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Discussion on Nitrogen and Phosphorus Removal Process Characteristics of Improved Oxidation Ditch

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Abstract

In order to enhance efficiency of the nitrogen and phosphorus removal of sewage treatment plant, Taking Wu Longkou sewage treatment plant project in Zhengzhou as an example, this article introduces the structure, the working principle, the craft character, as well as the problems existed in the practical application of the improved oxidation ditch, and raises some corresponding processing countermeasures. Looked from the running situation of Wu Longkou sewage treatment plant, the improved oxidation ditch have certain advantages in city sewage treatment, such as high organic removing efficiency, good removing effect of nitrogen and phosphorus, low investing expenses and operating cost and so on. It is a craft that is worth promoting in urban sewage treatment.

Keywords: Improved oxidation ditch; Urban sewage; Nitrogen and phosphorus removal

1. Introduction

Oxidation ditch is also named continuous loop reactor which is variation of Activated sludge. It becomes the main tendency in urban sewage treatment and is improved and grown in practical application after the technology of oxidation ditch was bought into China in 80th20 century and developed vapidly[1]. Improved oxidation ditch is an oxidation ditch that is improved according to the treated sewage in which the flow and quality are unstable and nitrogen and phosphorus content are high. In order to optimize craft, now combining with the practical application of Wu Longkou sewage treatment plant, we discuss the characteristics on Nitrogen and Phosphorus Removal Process of Improved Oxidation Ditch.

2. The Process and Treatment Effect

Wu Long Kou sewage treatment plant in ZhengZhou treats 100,000m^3 sewage every day, of which 50,000m^3 is treated by the depth and reused in the Jinshui River as water of the landscape, so the secondary effluent water must be in higher quality. It requires not only high efficiency of nitrogen and phosphorus removal but also strong resistant capacity of impact and stable operation on the selection of

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sewage treatment process. In this case, drawing fruits of many research and experience of sewage treatment plants in domestic and foreign [2-3], Wu Long Kou sewage treatment plant chooses improved oxidation ditch process, shown in figure 1.Passing by grid and swirl depositional pond, sewage enters the improved oxidation ditch. The improved oxidation ditch is intensive Nitrogen and phosphorus removal process, which is running according to the improved A^2/O.That is to put the pre-anoxic pond and anaerobic pond in front of the oxidation ditch and make water enter dividually. So that it can overcome the contradictions existed in the nitrogen and phosphorus removal of the traditional oxidation ditch. After more than two years since it has started running in June 2005, it has been proved to be a steady craft and had good efficiency. From the running shown in table 1, we can see that the efficiency of nitrogen and phosphorus removal process is quite high and all the water quality indicators have reached the secondary standard of "integrated wastewater discharge standard "(GB8978-1996).

Table 1 Treatment Effect unit: mg/L

Project	*BOD_5*	*COD_{cr}*	*SS*	*NH_3-N*	*TP*
The influent water quality	180~250	400~550	200~320	40~60	4.0~6.0
The effluent water quality	10~20	20~60	10~30	1~10	0.5~1.5

3. The Structure of Improved Oxidation Ditch and Principles of Nitrogen and Phosphorus Removal

There are three parts in the improved oxidation ditch, which are pre-anoxic pond, anaerobic pond and oxidation ditch. The reason of using the improved oxidation ditch is to ensure the efficiency of nitrogen and phosphorus removal according to the condition of influent and effluent water. In order to obtain a more stable phosphorus removal rate, we install anaerobic pond in the front of the system. On the one hand, it can provide necessary retention space and comfortable environmental conditions for phosphate accumulating bacteria's releasing phosphorus adequately. This help to enhance the efficiency of phosphorus removal. On the other hand, it can improve sludge setting performance, prevent filamentous from growing and improve the stability of system. Moreover, because of the high nitrogen and a little lack of carbon content in the influent water, the gentrification process could not be accomplish completely, so the nitrate nitrogen content in returning sludge is high. If no appropriate measures are taken, returning sludge will bring lots of nitrogen into anaerobic pond, which will inhibit accumulating phosphate bacteria from releasing phosphorus and affect the efficiency of phosphorus biological removal. As to this case, install a returning sludge gentrification pool in front of anaerobic pond (that is pre-anaerobic pool) that make the returning sludge enter anaerobic pool after the completion of nitrate nitrogen's gentrification process there. So lots of NO_3-N and NO_2-N in returning sludge is reduced to N_2 released into air, and it help to maintain the concentration of nitrate nitrogen under 1.5 mg/L and ensure the effect of biological phosphorus. In order To ensure the carbon which returning sludge needs during the gentrification in pre-hypoxia pond, there is 10 percent of influent water entering pre-hypoxia pond directly and the remaining 90 percent entering anaerobic pond. Blast microspores aeration apparatus and diving mixer are installed interval in oxidation ditch to make dissolved oxygen vary with sections. The dissolved oxygen is low where is far from aeration apparatus and form hypoxia area in some section of oxidation ditch where can realize gentrification. Therefore, dissolved oxygen, organic compounds and ammonia in the oxidation ditch are good for the biotical flocculation and gentrification of activity sludge, then completing adsorption-deviation of organic compounds and the nitrification and demystification of ammonias. At the

same time, after releasing phosphorus adequately in anaerobic pond, accumulating phosphate bacteria can absorb phosphorus excessively in oxidation ditch where there is enough oxygen. Then it is released in the form of remaining sludge which deposit in the sedimentation tank and achieve the purpose of phosphorus removal.

4. Process Feature and Problem Existed in the Practical Application

4.1 Process Feature

- On the whole, the process has reasonable technology and good effect .Not only it had a high efficiency of nitrogen and phosphorus removal and its others water quality indicators are all better than the design goal. But also this process has small footprint, less sludge production, convenient operation and management and so on.
- In order to avoid aeration affecting the operational efficiency of hypoxia pool and anaerobic pond of biological system in the process of desisting, the process uses swirl girt chamber but not aeration girl chamber.
- Because of the high NH_3-N content in sewage, the nitrate nitrogen in returning sludge may have an impact on phosphate accumulating bacteria's releasing phosphorus process in anaerobic pond. On the one hand, we install pre-hypoxia tank in front of anaerobic pond for the gentrification of nitrate nitrogen. On the other hand, divide the influent water into two groups to provide the carbon needed in the gentrification Therefore, the process ensures a higher efficiency of NH_3-N removal on without affecting the efficiency of TP removal. It has solved the problem of affecting each other in nitrogen and phosphorus removal in the traditional oxidation ditch.
- Interval installing blast microspores aeration devices and diving on the surface mixer instead of the traditional mechanical aeration can form hypoxia area by man and accomplish gentrification, without the need of internal returning. At the same time, the system has the advantage of pushing flow and completely mixing. It also had strong ability of absorbing oxygen, high rate of using oxygen and low operating costs. Moreover, it can avoid the sludge assembling. The whole system has strong resistant capacity of shock loading and reliable operation, and good quality of effluent water.
- The sedimentation tank used in the project is formed by improving the effluent weir and pool structure of traditional sedimentation tank .We install additional baffle at the bottom of the effluent weir plate. It can effectively prevent effluent water taking suspended sludge away, ensure the SS concentration low in effluent water and conquer the problem of high SS concentration and unstable water quality which results from short flows and density flows of suspended solids resulting from poorly water designed in traditional sedimentation tank.
- The sludge treatment uses whole closed thicken sludge dewatering machine and closed sludge conveying and drying equipment. It has high efficiency and can make sludge moisture reduce to 75-80%. Besides it can avoid smell causing bad effects.

4.2 Problems in the Operation

- Contradictions in nitrogen and phosphorus removal. In order to enhance the efficiency of nitrogen and phosphorus removal, Wu Long Kou sewage treatment plant uses the oxidation ditch technology, which operates, in the form of improved A^2/O. At the beginning of the operation, the efficiency of nitrogen removal was very high and the concentration of NH_3-N in effluent water was no more than 1mg/L and the removal rate was higher than 99%. On the other hand, the concentration of TP was often more than

1.5mg/L, but the removal rate could not reach 40%. This was mainly because nitrogen and phosphorus removal's requirements of sludge age are different. Nitrogen removal required a longer sludge age, but phosphorus removal required a shorter sludge age. After adjusting sludge age to be 16d around and adjusting the C/N and C/P through adapting the ratio of influent water of pre-hypoxia and anaerobic pool, the efficiency of phosphorus removal has been enhanced and the efficiency of nitrogen removal keeps higher than 90%. Moreover, the project should adjust sludge age to change activity biomass according to seasons. In summer, the flow of sludge should be reduced and the sludge age should be shortened. But in winter, it's opposite.

- Issue of sludge rising. In the early period of running, shortly after all the effluent water indicators of secondary sedimentation tank reached the designed goals, bulk sludge begun to rise and the ss in effluent water increased rapidly to maximum at 200 mg/l. Rising sludge was dark yellow and its surface was rough. After broken up, the sludge grain that was coarse and had a high density begun to sink with no stench. This was mainly because the microspores aeration devices which is used in the process had high efficiency of aeration .The hypoxia area of oxidation ditch still maintained higher dissolved oxygen concentration, so the denitrification was difficult to begin and most of the nitrogen which was in the form of nitrate nitrogen made the nitrate nitrogen content in the secondary sedimentation tank high. After lots of nitrate nitrogen entered secondary sedimentation tank, microbial in the sludge used up dissolved oxygen and began to denitrify and produce a large number of small bubble N_2 assembled in the sludge. It accumulated until sludge density was less than sewage density and then rising sludge would form by disturbance in the water or blowing sludge plate's mechanical disturbance. As to this problem, on the one hand, we regulated the aeration and kept the dissolved oxygen content at 2 to 3 mg/L in anaerobic area, and at 0.5-0.9mg/L in hypoxia area. It help to realize gentrification and reduce the nitrate nitrogen content in secondary sedimentary tank .At the same time, increased the aeration of the outlet to maintain the dissolved oxygen concentration higher than 3mg/L in effluent water, and that could ensure there was dissolved oxygen in secondary sedimentation tank. Besides increased the volume of sludge. Reduced the sludge concentration at 3500-4000mg/L, shortened the sludge age and reduced the time sludge stayed in the secondary sedimentation tank to reduce the risk of denitrification in the secondary sedimentation tank and sludge aging.
- The problem of the dross in sewage. In the operation of Wu Longkou sewage treatment plant, a large number of white and small floating things are found in the middle and bank of the oxidation ditch and the secondary sedimentation tank. Thin is mainly due to 60 percent of the sewage which was treated in the plant is industrial waste -water, of which quality is complex. The detergent and some industrial surfactant existing in the sewage form chemical foam drosses in the agitation and aeration process which could small can release with the effluent water of secondary sedimentation tank, resulting in the decrease of the effluent water quality. Solving the problem, we use defamers and install blow slag facility in the final culvert of the oxidation ditch to control the problem of dross in the sewage.

5. Conclusion

Wu Long Kou sewage treatment plant uses nitrogen and phosphorus removal process of improved oxidation ditch .It has overcome the contradictions in the traditional nitrogen and phosphorus removal process .In the last two years, it has effectively controlled the problems in the operation .It has stable operation, good water quality and high efficiency of nitrogen and phosphorus removal. Every of water quality indicator has achieved standards .At the same time, the process has small footprint, low investing expenses and operating cost and so on. It's a worth promoting craft in city sewage treatment

References

[1] Zhu Jingping, Cai Limin. The development of oxidation ditch technology [J]. Sichuan Enviroment, 2004,23(4): 57-60.

[2] Qu Yuezhou, Hu Yongyou. Oxidation ditch sewage treatment technology and engineering examples [M] Beijing: Chemical Industry Publishing House, 2005.

[3] Gao Tingyao, GuGuowei. Water pollution control engineering [M] Beijing: Higher Education Press, 1999.

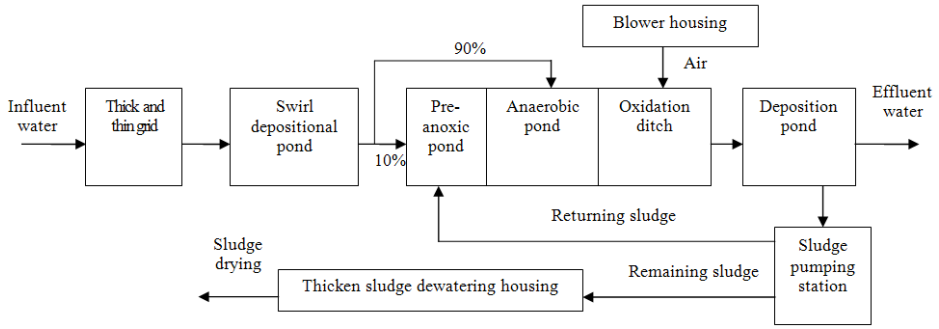

Figure 1. The process of improved oxidation ditch